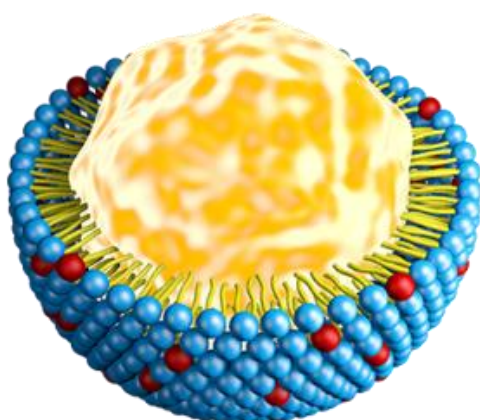


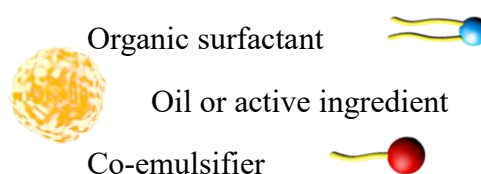
Using High-Pressure Homogenizers for Nanoemulsions



Nanoemulsions are ultra-fine mixtures of water and oil, unlike regular emulsions which appear cloudy. They're made up of tiny droplets typically in the range of 20 to 200 nanometers, smaller than those found in typical emulsions, giving them unique properties and applications. They offer improved stability, bioavailability, and controlled release properties, making them highly valuable in pharmaceuticals, cosmetics, and food industries.



A structure of Nanoemulsion



possible excipient includes membrane stabilizer, taste-blocker, anti-oxidant

Structure of nanoemulsions

How to process nanoemulsions?

Processing nanoemulsions involves several methods tailored to achieve specific characteristics:

1. High Energy Methods:

High-Pressure Homogenization: This technique employs elevated pressure to drive macroemulsions through a small opening, resulting in nano-sized droplets through hydraulic shear, cavitation, and turbulence.

Ultrasonication: Utilizes ultrasonic waves to induce cavitation bubbles, breaking down larger emulsion droplets into nano-sized ones.

2. Low Energy Methods:

Phase Inversion Emulsification: Leverages chemical potential from the constituents of the oil-water system to modify temperature or composition.

Self-Nanoemulsification: Relies on chemical interactions within the emulsion components to spontaneously form nanoemulsions.

Each method offers unique advantages based on the desired product characteristics. High-Pressure Homogenization, in particular, is highly effective in achieving stable and uniform nanoemulsions with very fine droplet sizes.

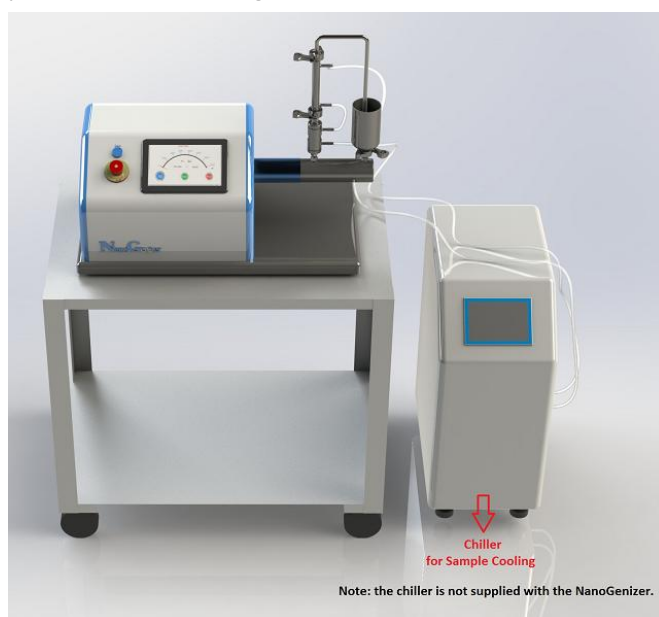
Advantages of Using High-Pressure Homogenizers in Nanoemulsions

Uniform Particle Size Reduction: High-pressure homogenizers create very fine and uniform droplet sizes, typically in the range of 20-200 nanometers. This uniformity enhances the stability and performance of the nanoemulsion.

Enhanced Stability: Nanoemulsions produced by high-pressure homogenization have superior stability compared to those made by conventional methods. The smaller droplet sizes reduce the likelihood of phase separation, improving the shelf life of the product.

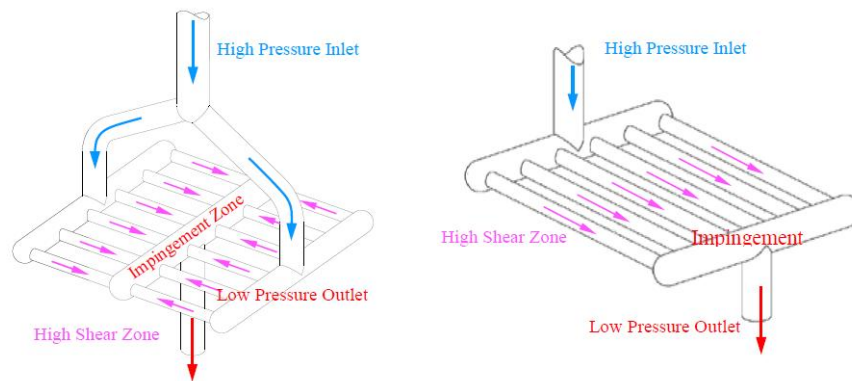
Increased Bioavailability: Smaller droplets have a larger surface area, which can improve the bioavailability of active ingredients in pharmaceuticals and nutraceuticals. This means that the active compounds can be more readily absorbed by the body.

Thermal Control Capability: The core processing unit of the high-pressure homogenizer, known as the Interaction Chamber, is equipped with real-time cooling ports. This feature makes the homogenizer ideal for processing temperature-sensitive compounds, ensuring their efficacy is preserved without degradation.



NanoGenizer high-pressure homogenizer connected to a chiller for temperature control

Guaranteed Scalability: High-pressure homogenizers are suitable for both small-scale laboratory research and large-scale industrial production, making it easier to transition from R&D to commercial manufacturing. Featuring a diamond interaction chamber (DIXC) as its core component, high-pressure homogenizers ensure consistency in treatment effects. The DIXC comes in single-slotted and multi-slotted variants, with the latter featuring multiple diamond micro-channels arranged in parallel to enhance treatment consistency and accommodate larger volumetric flow rates.



Schematic of Multi-slotted Y-type and Z type microfluidic diamond interaction chamber of High Pressure Homogenizers

High-pressure homogenizers play a pivotal role in unlocking the full potential of nanoemulsions. Their ability to achieve stable, uniform, and efficient nanoemulsions with precise droplet sizes positions them as indispensable tools in modern manufacturing processes, driving innovation and advancement across various sectors.